

WHAT IS CLAIMED IS:

1 A timing error compensation system in an OFDM/CDMA
(Orthogonal Frequency Division Multiplexing/Code Division Multiple Access)
5 communication system, comprising:

a pilot symbol inserter for receiving a spread data symbol stream, and
periodically inserting N pilot symbols each having a same phase using a specific
period in a symbol unit to compensate a timing error of a receiver.

10 2. A timing error compensation system in an OFDM/CDMA
communication system said OFDM/CDMA communication system including an
analog-to-digital converter which converts an OFDM signal to a digital OFDM
symbol stream using sampling synchronization; a data symbol stream received
from a transmitter, in which a pilot symbol is inserted at intervals of a
15 predetermined number of data symbols; a guard interval remover for removing a
guard interval inserted in the OFDM symbol using frame synchronization; and a
fast Fourier transform (FFT) device for performing fast Fourier transform on the
guard interval-removed OFDM symbol and outputting a data symbol stream; said
timing error compensation system comprising:

20 a pilot symbol detector which receives the data symbol stream and
detecting the pilot symbols inserted in the data symbol stream at predetermined
intervals in a symbol unit; and

a timing compensator which determines a linear phase difference line for
the detected pilot symbol using the pilot symbol and a reference symbol
25 previously known by the receiver, generates a timing error estimation signal
according to the determined linear phase difference line, and provides the timing
error estimation signal to the analog-to-digital converter and the guard interval

remover so as to determine the sampling synchronization and the frame synchronization.

3. The timing error compensation system as claimed in claim 2, wherein the timing compensator comprises:

a phase detector to detect a phase of the pilot symbol in a sample data unit;

a phase difference detector to detect a phase difference between the detected phase of the pilot sample and a reference phase and converting the detected phase difference to a value within a specific range;

a phase fluctuation estimator to determine a phase difference line by accumulating the phase difference in a symbol unit, and counting the number of transitions in the phase difference line; and

a timing error compensation signal generator to generate a timing error estimation signal to compensate for a timing error according to the count value of the transition number.

4. The timing error compensation system as claimed in claim 3, wherein the phase difference between the phase of the pilot sample and the reference phase is calculated by

$$\begin{aligned} diff_{phase}(k) &= \angle Y'_m(k) - \angle X_m(k) \\ &= \angle X_m(k - k_e) - \angle X_m(k) + \frac{2\pi n_e}{N} k - \frac{2\pi n_e k_e}{N} \\ &\quad + 2\pi k_e \frac{m(N+G)}{N} + p_e + \angle W_m[k - k_e] \end{aligned}$$

~~5~~ A timing error compensation system in an OFDM/CDMA communication system, which receives an OFDM signal, said OFDM/CDMA

communication system comprised of a data symbol stream received from a transmitter, in which a pilot symbol is inserted at periods of a prescribed number of data symbols and outputting a data symbol stream through a fast Fourier transform, said timing error compensation system comprising:

5 a pilot symbol detector to detect a pilot symbol inserted in the data symbol stream at prescribed intervals;

 a timing compensator to determine a linear phase difference line for the detected pilot symbol, and generate a timing error estimation signal according to the determined linear phase difference line;

10 an analog-to-digital converter to determine sampling synchronization according to the timing error estimation signal from the timing compensator, and converting the OFDM signal to a digital OFDM symbol by the determined sampling synchronization; and

15 a guard interval remover to determine frame synchronization according to the timing error signal from the timing compensator, and to remove a guard interval inserted in the OFDM symbol from the analog-to-digital converter.

6. The timing error compensation system as claimed in claim 5, wherein the timing compensator comprises:

20 a phase detector to detect a phase of the pilot symbol in a sample data unit;

 a phase difference detector to detect a phase difference between the detected phase of the pilot sample and a reference phase and converting the detected phase difference to a value within a specific range;

25 a phase fluctuation estimator to determine a phase difference line by accumulating the phase difference in a symbol unit, and counting the number of transitions in the phase difference line; and

a timing error estimation signal generator to generate a timing error estimation signal for compensating a timing error according to the count value of the transition number.

5 7. The timing error compensation system as claimed in claim 6, wherein a timing error estimation signal for compensating a timing error within a sample period is generated when the transition number count value is less than 1, and a timing error estimation signal for compensating a timing error over the sample period is generated when the transition number count value is greater than 1.

10 ~~8.~~ A method for compensating a timing error in an OFDM system, which inserts a pilot symbol in a data symbol stream in a symbol unit at intervals of a predetermined number of data symbols, the method comprising the steps of:

15 detecting a pilot symbol inserted in a received data symbol stream at predetermined intervals;

 calculating a phase difference between the detected phase of the pilot symbol and a reference phase, and converting the calculated phase to a phase difference value within a specific range; and

20 compensating a timing error using a transition number of the converted phase difference value.

 9. The method as claimed in claim 8, wherein the phase difference range is $\pm\pi$.

25 ~~10.~~ A method for compensating a timing error in an OFDM system, which inserts a pilot symbol in a data symbol stream in a symbol unit at intervals of a predetermined number of data symbols, the method comprising the steps of:

detecting a pilot symbol inserted in a received data symbol stream at predetermined intervals;

detecting a phase of the detected pilot symbol in a sample data unit;

calculating a phase difference between the detected phase of the pilot symbol and a reference phase, and converting the calculated phase to a phase difference value within a specific range;

counting the number of transitions within a specific range for the respective data samples;

determining whether the count value is larger than a prescribed value; and

compensating a timing error, when the count value is larger than the prescribed value.

11. The method as claimed in claim 10, comprising the additional step of compensating, when the count value is less than the prescribed value, the timing error by converting the count value to a phase difference line and estimating a slope of the phase difference line.

12. The method as claimed in claim 11, wherein the slope of the phase difference line is calculated by

$$\text{slope} = \frac{\text{avg}_{\text{second}} - \text{avg}_{\text{first}}}{\frac{N}{2}} \approx a$$

13. The method as claimed in claim 10, wherein the prescribed value is '1'.

14. The method as claimed in claim 10, wherein the phase difference range is $\pm\pi$.